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(54) [Title of the Invention] Concentrator-Type Solar Power Generator and Concentrator-Type Solar Generator Module With Diffraction plane
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(57) [Abstract]

[Problem] To obtain a concentrator-type solar power generator with a high light-concentrating multiple and high light utilization efficiency.

[Solution] A concentrator-type solar power generator comprising a light-receiving plane, a diffraction plane, a medium filling the space between the light-receiving plane and the diffraction plane, and a light-receiving device in which at least some of its surface comes into contact with the medium, wherein the refraction index of the medium is greater than the refraction index of the light-receiving plane.

[Claims]

[Claim 1] A concentrator-type solar power generator comprising a light-receiving plane, a diffraction plane, a medium filling the space between the light-receiving plane and the diffraction plane, and a light-receiving device in which at least some of its surface comes into contact with the medium, wherein the refraction index of the medium is greater than the refraction index of the light-receiving plane.

[Claim 2] The concentrator-type solar power generator described in claim 1, wherein the diffraction plane is a reflective diffraction plane.

[Claim 3] The concentrator-type solar power generator described in claim 2, wherein the reflective diffraction plane is a blazed diffraction plane.

[Claim 4] The concentrator-type solar power generator described in claim 3, wherein the blazed diffraction plane has an asymmetrical blaze angle.

[Claim 5] The concentrator-type solar power generator described in claim 4, wherein a blazed diffraction plane is installed symmetrically to the right and left of the diffraction plane.

[Claim 6] A concentrator-type solar power generating module, wherein a plurality of concentrator-type solar power generators described in claims 1 through 5 are arranged to form a module.

[Claim 7] The concentrator-type solar power generating module described in claim 6, wherein the medium is continuous between the plurality of concentrator-type solar power generators.

[Detailed Description of the Invention]

[0001]

[Technical Field of the Invention] The present invention relates to a concentrator-type solar power generator and a concentrator-type solar generator module with a diffraction plane.

[0002]

[Prior Art] An example of a concentrator-type solar power generator comprising a light-receiving plane, a specular reflective plane, a medium filling the space between the light-receiving plane and the specular reflective plane, and a light-receiving device in which at least some of the plane comes into contact with the medium was disclosed in "New Family of 2-D Non-Imaging Concentrators: Compound Triangular Concentrators" in Applied Optics, Vol. 24, No. 22 (1985), pp. 3872-3876. In the structure of the prior art, as shown in FIG 21 (a), when incoming light 1 is directed towards the light-receiving plane 4 of the concentrator and reflected by the specular reflective plane 32 perpendicular to incoming light 2, the reflected light 3 is outputted from the light-receiving plane 4 to the outside along the same light path as the incoming light 2 but in the opposite direction irrespective of the refraction index of the medium 5.

[0003] In order to avoid this, as shown in FIG 21 (b), the specular reflective plane 32 is inclined with respect to the light-receiving plane 4, the light 2 incoming towards the concentrating device is reflected by the specular reflective plane 32, and the angle of incidence 33 is increased when directed towards the light-receiving plane 4. The light-receiving plane in this structure is completely reflective because the refractive index of the medium 5 is greater than the refractive index to the outside of the light-receiving plane 4. The complete reflection of the inclined specular reflective plane and light-receiving plane is used to close the incoming light inside the concentrating device and eventually direct it towards the light-receiving device 6. However, as shown in FIG 21 (c), the angle of inclination 33 of the reflected light towards the light-receiving plane 4 is not sufficiently large because of the angle of inclination of the incoming light 1, so light escapes to the outside of the concentrating device.

[0004]

[Problem Solved by the Invention] Because a specular reflective plane is used in the prior art, the ratio of the area of the incoming plane of the concentrating device to the area of the light-receiving plane of the light-receiving device or the light-concentrating ratio is B/A , where the area of the light-receiving plane of the light-receiving device is A and the area of the incoming plane of the concentrating device is B . When the light-concentrating ratio is large, it is difficult to increase the light utilization efficiency.

[0005] A purpose of the present invention is to provide a technology able to simplify the macroscopic structure of a concentrator-type solar power generator.

[0006] Another purpose of the present invention is to provide a technology able to improve both the light utilization efficiency and light-concentration factor of a concentrator-type solar power generator.

[0007] Other purposes and novel features of the present invention are elucidated in the specification and drawings.

[0008]

[Means of Solving the Problem] The following is a summary of the invention disclosed in this application.

[0009] (1) A concentrator-type solar power generator comprising a light-receiving plane, a diffraction plane, a medium filling the space between the light-receiving plane and the diffraction plane, and a light-receiving device in which at least some of its surface comes

into contact with the medium, wherein the refraction index of the medium is greater than the refraction index of the light-receiving plane.

[0010] (2) The diffraction plane is a reflective diffraction plane.

[0011] (3) The reflective diffraction plane is a blazed diffraction plane.

[0012] (4) The diffraction plane is a reflective diffraction plane.

[0013] (5) A blazed diffraction plane is installed symmetrically to the right and left of the diffraction plane.

[0014] (6) A plurality of these concentrator-type solar power generators are arranged to form a module.

[0015] (7) The medium is continuous between the plurality of concentrator-type solar power generators in the concentrator-type solar power generator module.

[0016]

[Embodiment of the Invention] The following is a more detailed explanation of the present invention with reference to embodiments (working examples).

[0017] In the embodiments of the present invention, the concentrator-type solar power generator comprises a light-receiving plane, a diffraction plane, a medium filling the space between the light-receiving plane and the diffraction plane, and a light-receiving device in which at least some of its surface comes into contact with the medium. The refraction index of the medium is also greater than the refraction index of the light-receiving plane. The light-receiving device uses a solar battery to convert sunlight into electric power.

[0018] FIG 1 is a simplified drawing of the concentrator-type solar power generator in an embodiment of the present invention.

[0019] The concentrator-type solar power generator in the embodiments has a structure with the cross-section shown in FIG 1 (a). In a light-concentrating device using a diffraction plane 7, the light 2 incoming towards the diffraction plane is not only reflected in the direction of specular reflection (zero-dimensional light direction) but also in the one-dimensional, negative one-dimensional, two-dimensional and negative two-dimensional direction depending on the microscopic structure of the diffraction plane 7 and the wavelength of the incoming light 1. Therefore, even when the light comes in perpendicular to the diffraction plane 7, all of the reflected light 3 does not pass along the same light path as the incoming light 2 but is divided and reflected in the zero-dimensional, one-dimensional, negative one-dimensional, two-dimensional and negative two-dimensional directions with respect to the diffraction plane 7. Therefore, the appropriate diffraction plane 7 has been designed to reflect all of the reflected light 3 with the light-receiving plane 4 and efficiently direct the light into the light-concentrating device.

[0020] Similarly, as shown in FIG 1 (b), the device can be designed so that all of the reflected light 3 is reflected by the light-receiving plane 4 even when light 1 comes in to the light-receiving plane 4 at an angle. All of the light can be reflected by the light-receiving plane 4 and taken into the light-concentrating device even when all of the reflected light has not been directed towards the light-receiving device 6 as shown in FIG 1 (c).

[0021] In this explanation, the energy distribution of the different dimensions of light when the incoming light 2 is diffracted is not mentioned. If the shape of the surface of the diffraction plane when viewed microscopically is the shape shown in FIG 2 (b), the portion of the different dimensions of light with a direction near the specular reflection direction with respect to the diffraction plane 7 viewed macroscopically is increased. Therefore, when the light-reflecting plane 4 and diffraction plane 7 are arranged parallel to each other, the portion of light reflected in the specular reflection direction is increased. In order to effectively prevent this, a blazed diffraction plane with a triangular wave shape can be used in which the microscopic shape of the surface of the diffraction plane is symmetrical as shown in FIG 2 (c) or asymmetrical as shown in FIG 2 (d).

[0022] Of course, the diffraction plane 7 can be flat or curved macroscopically, and have periodic triangular lattice grooves with a repeating pitch 9 in the microscopic range of the wavelengths of the light being handled. In order to maintain a high diffracting efficiency, the diffractive light used has to be ten-dimensional or less. The repeating pitch 9 of the diffraction plane has to be ten times or less the wavelength of the light in the medium. Use of three-dimensional diffracted light or less is preferred.

[0023] The light-concentrating device can have a structure in which a flat plate-like light-receiving device 6 with a rectangular cross-section is arranged between the light-receiving plane 4 and the diffraction plane 7 and the space surrounded by the diffraction plane 7 and the light-receiving plane 4 is filled with a medium 5 as shown in FIG 3 (a), or a structure in which a cylindrical or spherical light-receiving device 6 with a round cross-section is arranged between the light-receiving plane 4 and the diffraction plane 7 as shown in FIG 3 (b).

[0024] FIG 4 (a) shows an example with a reflective curved plane 13. Here, a light-receiving device 6 with a rectangular cross-section is installed on the light-receiving plane end parallel to the light-receiving plane. The light reflected by the diffraction plane 7 is directed directly or reflected by the reflective curved plane 13 towards the light-receiving device 6. In this shape, the reflective curved plane 13 is a specular reflective plane but can effectively concentrate light if there is a diffraction plane. Also, as shown in FIG 4 (b), the light-concentrating efficiency can be increased by installing the diffraction plane 7 at an angle with respect to the light-receiving plane 4.

[0025] FIG 5 (a) shows a structure in which an inclined diffraction plane 7 is arranged below a flat light-receiving plane 4, and the direction of the lattice grooves 14 in the diffraction plane are formed in the direction perpendicular to the direction of incline. In this structure, the surface 8 of the diffraction plane 7 has the microscopic cross-section shown in FIG 5 (c). FIG 5 (b) shows a structure in which an inclined light-receiving plane 4 is arranged above a flat diffraction plane 7. This allows a high light-concentrating efficiency to be obtained in a light-concentrating device with a two-dimensional structure.

[0026] Also, as shown in FIG 6 (a) and (b), a structure can be used in which the diffraction grooves are formed in the direction of the inclined plane. This combines the light-concentrating effect of the prismatic structure formed by the light-receiving plane 4 and the inclined plane 7 with the light-concentrating effect of the diffraction. In this structure, the surface 8 of the diffraction plane 7 has the microscopic cross-section shown in FIG 6 (c).

[0027] In the structures shown in FIG 5 and FIG 6, the light-receiving device 6 has a plate-like shape. However, it can also be cylindrical as shown in FIG 7 as well as spherical or rectangular. It can also be a two-dimensional structure with an uneven surface.

[0028] The microscopic structure of the diffraction plane is shown in FIG 8. If the structure shown in FIG 8 is symmetrical from left to right, the light coming in from the center to the right side 15 can be directed to the light-receiving device 6 on the left side and the light coming in from the center to the left side 16 can be directed to the light receiving device 6 on the left side to increase the light-concentrating efficiency. Preferably, the microscopic shape of the surface 8 of the diffraction plane is such that the asymmetrical triangle shapes are arranged from left to right as shown in FIG 8.

[0029] Even in the structure shown in FIG 9, the microscopic shape of the surface 8 of the diffraction plane should change from the center of the device towards the left and right ends.

[0030] If the diffraction grooves are formed in the direction of the inclined plane as shown in FIG 10 (a), the microscopic cross-sectional shape of the diffraction grooves should be changed to the right and left of the center of the device so that the blaze angle more effectively directs the diffracted light to the light-receiving device 6 as shown in FIG 10 (b) [cross-sectional shape A-A' in (a)].

[0031] FIG 11 shows a diffraction plane 7 with an uneven shape. Here, the structure should be such that the diffraction grooves 14 are arranged in the direction of the inclined diffraction plane 7. The light-receiving device 6 can be arranged in the direction of the uneven shape of the diffraction plane 7 as shown in FIG 11 (a) or can be arranged in the perpendicular direction as shown in FIG 11 (b). It can also be arranged in a direction between these two directions.

[0032] FIG 12 (a) and (b) show structures in which the cross-section of the light-receiving plane 4 is curved. Here, the light-receiving plane 4 of the light-concentrating device does not have to be flat. The diffraction plane 7 can also have the cross-sectional shapes shown in FIG 12 (c) and (d). The light-concentrating device can have a two-dimensional structure extending in front and behind the plane of the sheet of paper on which the drawings appear or a structure rotated around the axis of rotation 30. Here, the direction 14 of the diffraction grooves can be along the cross-section of the diffraction plane 7 or circumferential.

[0033] FIG 13 (a) and (b) are examples in which the diffraction grooves are arranged two-dimensionally. Here, the diffraction plane is viewed from above. In this arrangement, the light is concentrated not only on the side plane of the light-receiving device 6 but in the directions around the light-receiving device. This improves the light-concentrating efficiency. When a plurality of light-receiving devices is made into a module as shown in FIG 14, a light-concentrating module with a large area is created. By using a two-dimensional diffracting lattice with diffraction grooves 14 extending in different directions, as shown in FIG 15, incoming light around the light-receiving device 6 can be effectively concentrated in two-dimensions.

[0034] FIG 16 shows the cross-sectional structure of the diffraction plane. Even more simple, as shown in FIG 16 (a), is a structure in which there is the desired microscopic waviness on the diffraction plane side of the medium 5 with a reflective material layer 17 such as one of metal on the surface.

[0035] Also, there is a structure with a rear surface protective layer 18 on the rear surface of the reflective material layer 17, as shown in FIG 16 (b), and a structure in which the desired intermediate layer 19 is installed between the reflective material layer 17 and the diffraction plane side of the medium 5, as shown in FIG 16 (c). This intermediate layer 19 can consist of an adhesive for bonding the reflective material layer 17 to the medium 5 or a

protective material for the reflective material layer 17, and can have the desired refraction index to increase the reflectivity of the reflective material layer 17.

[0036] FIG 16 (d) shows an example in which the rear surface of the medium 5 is microscopically flat, and the intermediate layer 19 is also flat on the medium 5 side. FIG 16 (e) shows a structure with an adhesive layer 20 between the intermediate layer 19 and the medium 5. These structures can also have additional layers where appropriate, such as an adhesive layer for bonding the various layers together in the structure or protective layers. Needless to say, the light-concentrating effect obtained is similar to the structures mentioned above.

[0037] In the structure shown in FIG 3 (a), the light-receiving device 6 is installed inside the light-concentrating device. However, the process used to install a light-receiving device 6 inside a light-concentrating device is complicated in actual practice. This can be avoided by using a structure in which a light-receiving device is installed on the surface of a light-concentrating device as shown in FIG 17 (a). Here, a second specular reflective mirror 35 is needed to direct the light to the surface of the light-receiving device 6. Also, a first specular reflective plane should be placed on the end plane where the light-receiving device 6 is not arranged. By using the diffraction plane around the specular reflective plane, the angle of incidence for the light incoming to the light-receiving device can be set. This also further increases the supplemental rate of the light at the light-receiving device.

[0038]

(Working Example 1) FIG 18 is a simplified drawing of the concentrator-type solar power generator and concentrator-type solar power module in the first working example of the present invention. The concentrator-type solar power module in the first working example, as shown in FIG 18, is designed to concentrate sunlight in a cylindrical light-receiving device and generate electric power.

[0039] First, the light-concentrating device has the structure shown in FIG 18 (a). The diffraction plane 7, as shown in FIG 16 (d), consists of sheets of aluminum reflective material 17, plastic front surface protective material 19 and plastic rear surface protective material 18 applied to the rear surface of the medium 5. Plastic is used as the medium 5.

[0040] Because refractive index of plastic 5 is approximately 1.5, the angle of inclination has to have an $\arcsin(1/1.5) = 41.8$ or less when the incoming light is reflected by the diffraction plane and directed towards the light-receiving plane. In order to do this, the blaze angle of the diffraction plane should be greater. The blaze angle in the first working example is 45 degrees.

[0041] Sunlight has a wide range of wavelengths. These range from 300 nm for ultraviolet light to several μm for far infrared light. Because this light is effectively concentrated by using diffraction, the device has to be designed so that the diffraction angle is large enough to diffract difficult short wavelength light. Because the refraction index is approximately 1.5, the wavelength of the light in the medium is $1/1.5$ the wavelength in air.

[0042] Because the shortest wavelength in sunlight is approximately 400 nm, two-dimensional diffracted light is used with respect to the shortest wavelength, and the repeating pitch of the microscopic waves in the diffraction plane 7 is 533 nm or two times the wavelength $400\text{ nm}/1.5$ inside the plastic.

[0043] A light-concentrating device consisting of several light-reflecting devices is surrounded by an aluminum frame 21. A plastic support 12 is arranged on the rear surface. This structure can be used to easily form a light-concentrating module with a higher light-concentrating efficiency than a light-concentrating device of the prior art using an inclined plane with large steps.

[0044]

(Working Example 2) FIG 19 is a simplified drawing of the concentrator-type solar power generator and concentrator-type solar power module in the second working example of the present invention.

[0045] The concentrator-type solar power generator in the second working example of the present invention is designed to concentrate sunlight on a light-receiving plane 6 consisting of a solar battery using a plate-like crystalline silicon semiconductor and output electric power.

[0046] First, the light-concentrating device has the structure shown in FIG 19 (a). The electric power generated by the light-receiving device 6 consisting of a solar battery is outputted from the electrodes installed in the portion 31 connected to the light-receiving device 6. Glass is used as the medium 5. The refractive index of the medium 5 is approximately 1.5. Because the shortest wavelength in sunlight is approximately 400 nm, three-dimensional diffracted light is used with respect to the shortest wavelength, and the repeating pitch of the microscopic waves in the diffraction plane 7 is 800 nm or three times the wavelength 400 nm/1.5 inside the glass.

[0047] Several light-reflecting device 6 are arranged as shown in FIG 19 (b), and surrounded by an aluminum frame 21. Surface cover glass 22 is also installed. The electric power generated by the light-receiving devices 6 is outputted from the first wiring 26 and the second wiring 27 via the first electrode 24 and second electrode 25 installed in the portion connected to the light-receiving devices positioned to the outside of the diffraction plane.

[0048] A support 12 with plastic protective film and electrode-protecting material 28 are installed on the rear surface. This structure is simple macroscopically, and forms a concentrator module with high concentrating efficiency. Solar batteries use semiconductor devices or photochemical reactions, but the effect of the present invention does not depend on the type of solar battery used.

[0049]

(Working Example 3) FIG 20 is a simplified drawing of the concentrator-type solar power generator and concentrator-type solar power module in the third working example of the present invention.

[0050] The concentrator-type solar power generator in the third working example of the present invention is designed to concentrate sunlight on a light-receiving plane 6 consisting of a solar battery using a plate-like crystalline silicon semiconductor and output electric power. First, the light-concentrating device has the structure shown in FIG 20 (a). The electric power generated by the solar battery is outputted from the electrodes installed in the rear surface of the light-receiving device 6. Glass is used as the medium 5. The refractive index of the medium 5 is approximately 1.5. Because the shortest wavelength in sunlight is approximately 400 nm, two-dimensional diffracted light is used with respect to

the shortest wavelength, and the repeating pitch of the microscopic waves in the diffraction plane 7 is 533 nm or three times the wavelength 400 nm/1.5 inside the glass.

[0051] Several light-reflecting devices 6 are arranged as shown in FIG 20 (b), and surrounded by an aluminum frame 21. The electric power generated by the light-receiving devices 6 is outputted from the first wiring 26 and the second wiring 27 via the first electrode 24 and second electrode 25 installed in the rear surface of the light-receiving devices. A plastic protective material 28 is also installed on the rear surface. In this module, both the first reflective plane 34 and the second reflective plane 35 form a single reflective plate. This structure is simple macroscopically, and forms a concentrator module with high concentrating efficiency. Solar batteries use semiconductor devices or photochemical reactions, but the effect of the present invention does not depend on the type of solar battery used.

[0052] The microscopic structure of the surface of the diffraction plane explained above does not have to match the shape in the drawings. It can also be uneven as long as it does not adversely affect the diffraction. When this plane is actually manufactured, there are limits to manufacturing precision and the plane may become misshapen. However, the effect of the present invention can be obtained if this does not impede the diffraction of light. The diffraction planes can be easily manufactured by creating a replica using the stamping method.

[0053] The present invention was explained in detail with reference to embodiments (working examples), but the present invention is by no means limited to these embodiments (working examples). Other variations are certainly possible within the scope of the claims.

[0054]

[Effect of the Invention] The following are effects typically obtained by the invention disclosed in this application.

[0055] (1) The macroscopic structure of concentrator-type solar power generators can be simplified.

[0056] (2) The light utilization efficiency and concentrating factor can be improved in a concentrator-type solar power generator.

[Brief Explanation of the Drawings]

[FIG 1] A simplified drawing of the concentrator-type solar power generator in an embodiment of the present invention.

[FIG 2] A drawing of the shape of the surface of the diffraction plane in the concentrator-type solar power generator of the present invention viewed microscopically.

[FIG 3] A simplified drawing of the concentrator-type solar power generator in another embodiment of the present invention.

[FIG 4] A simplified drawing of the concentrator-type solar power generator in another embodiment of the present invention.

[FIG 5] A simplified drawing of the concentrator-type solar power generator in another embodiment of the present invention.

[FIG 6] A simplified drawing of the concentrator-type solar power generator in another embodiment of the present invention.

[FIG 7] A simplified drawing of the concentrator-type solar power generator in another embodiment of the present invention.

[FIG 8] A simplified drawing of the concentrator-type solar power generator in another embodiment of the present invention.

[FIG 9] A simplified drawing of the concentrator-type solar power generator in another embodiment of the present invention.

[FIG 10] A simplified drawing of the concentrator-type solar power generator in another embodiment of the present invention.

[FIG 11] A simplified drawing of the concentrator-type solar power generator in another embodiment of the present invention.

[FIG 12] A simplified drawing of the concentrator-type solar power generator in another embodiment of the present invention.

[FIG 13] A simplified drawing of the concentrator-type solar power generator in an embodiment of the present invention viewed from above.

[FIG 14] A simplified drawing of the diffraction plane of the concentrator-type solar power module in an embodiment of the present invention viewed from above.

[FIG 15] A simplified drawing of the diffraction plane of the concentrator-type solar power generator in another embodiment of the present invention viewed from above.

[FIG 16] A diagram of the cross-sectional structure of the diffraction plane of the concentrator-type solar power generator in an embodiment of the present invention.

[FIG 17] A simplified drawing of the concentrator-type solar power generator in another embodiment of the present invention.

[FIG 18] A simplified drawing of the concentrator-type solar power generator and concentrator-type solar power module in the first working example of the present invention.

[FIG 19] A simplified drawing of the concentrator-type solar power generator and concentrator-type solar power module in the second working example of the present invention.

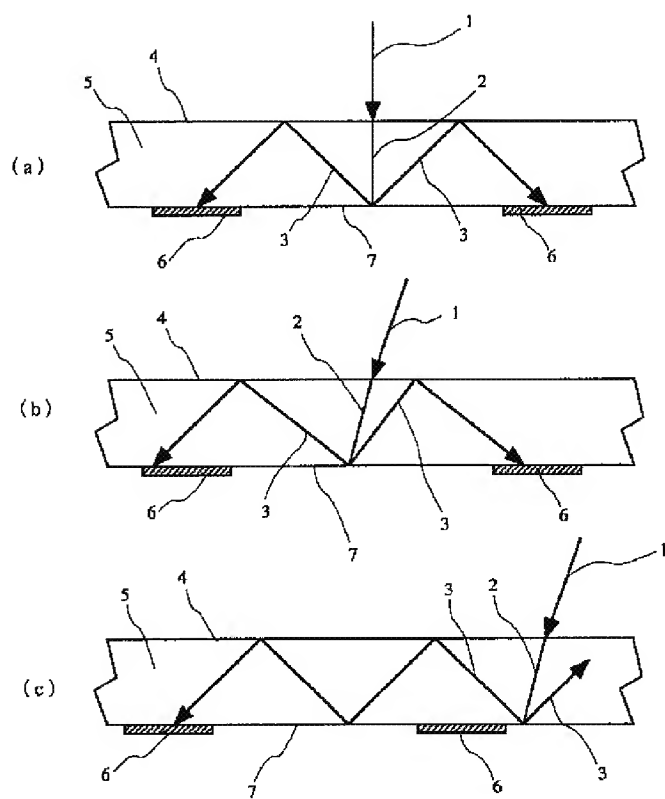
[FIG 20] A simplified drawing of the concentrator-type solar power generator and concentrator-type solar power module in the third working example of the present invention.

[FIG 21] A simplified drawing of a concentrator-type device of the prior art.

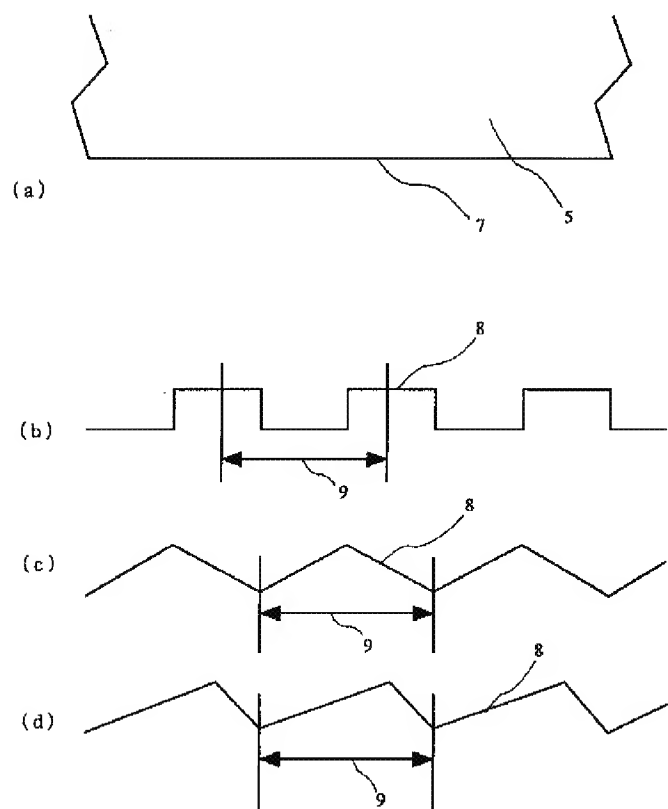
[Key to the Drawings]

1 ... Incoming Light, 2 ... Incoming Light to Concentrator Device, 3 ... Reflected Light, 4 ... Light-Receiving Plane, 5 ... Medium, 6 ... Light-Receiving Device, 7 ... Diffraction Plane, 8 ... Surface of Diffraction Plane Viewed Microscopically, 9 ... Diffraction Groove Pitch, 10 ... Thermal Insulation Layer, 11 ... Cover, 12 ... Support, 13 ... Curved Reflecting Plane, 14 ... Diffraction Groove Direction, 15 ... Right Side, 16 ... Left Side, 17 ... Reflective Material Layer, 18 ... Rear Surface Protective Layer, 19 ... Plane Layer, 20 ... Adhesive Layer, 21 ... Frame, 22 ... Cover Glass, 23 ... Thermal Insulation Plate, 24 ... First Electrode, 25 ... Second Electrode, 26 ... First Wiring, 27 ... Second Wiring, 28 ... Protective Material, 29 ... Direction of Rotation, 30 ... Rotational Axis, 31 ... Portion Connected to Light-Receiving Device Positioned Outside Diffraction plane, 32 ... Specular Reflective Plane, 33 ... Angle of Incidence, 34 ... First Reflective Plane, 35 ... Second Reflective Plane, 36 ... Outgoing Light From Outgoing Plane, 37 ... Outgoing Plane

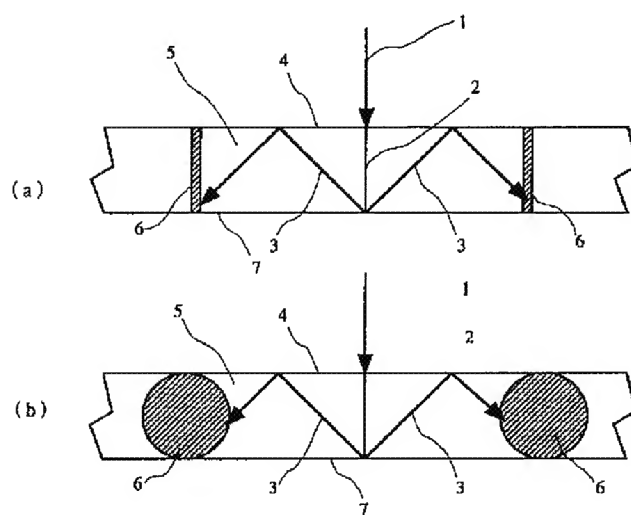
[FIG 1]



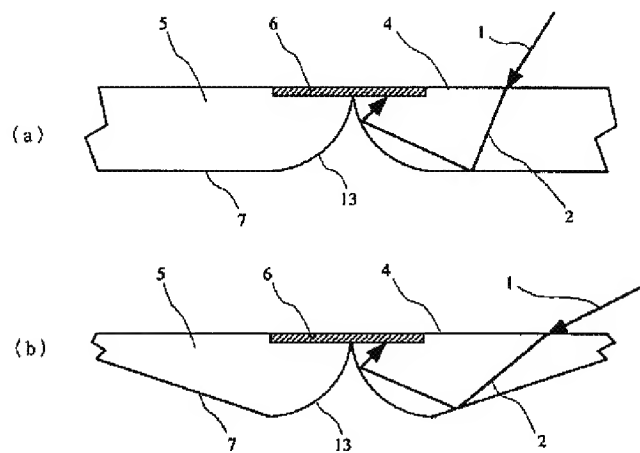
[FIG 2]



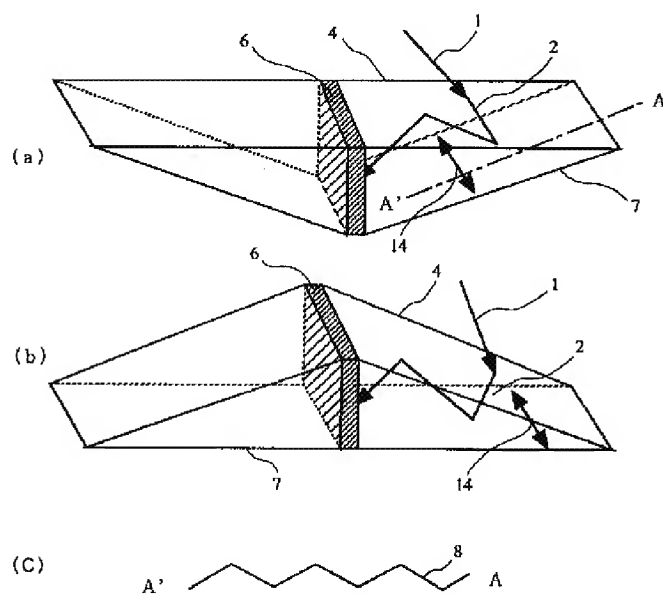
[FIG 3]



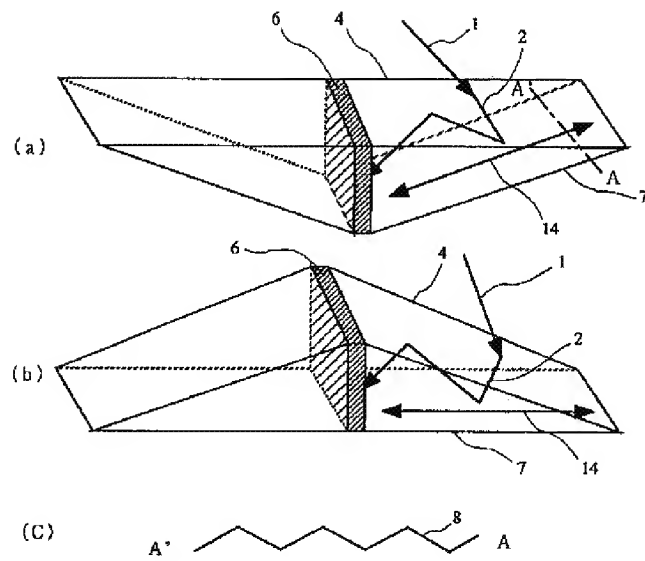
[FIG 4]



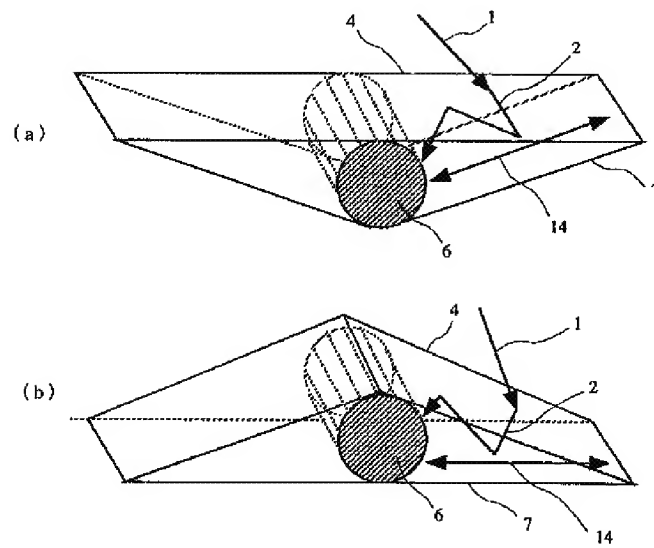
[FIG 5]



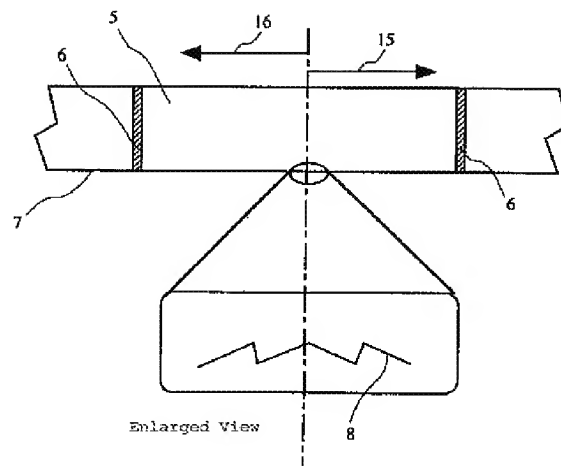
[FIG 6]



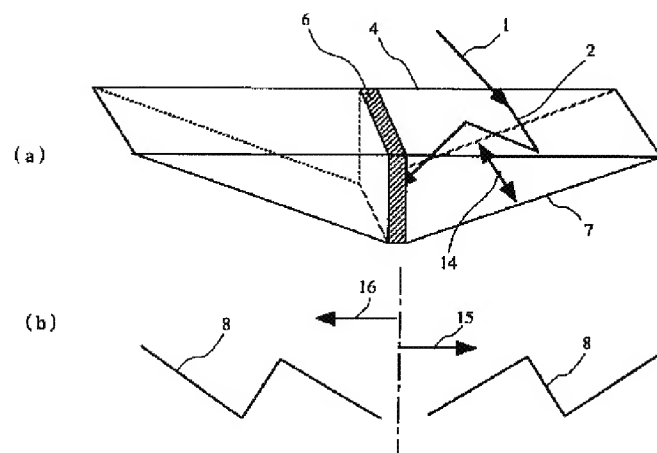
[FIG 7]



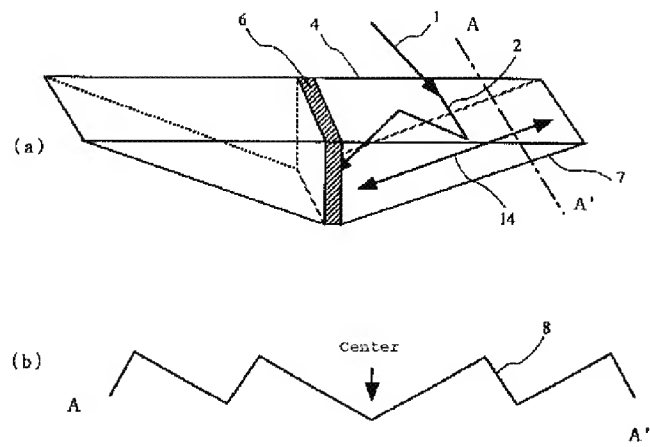
[FIG 8]



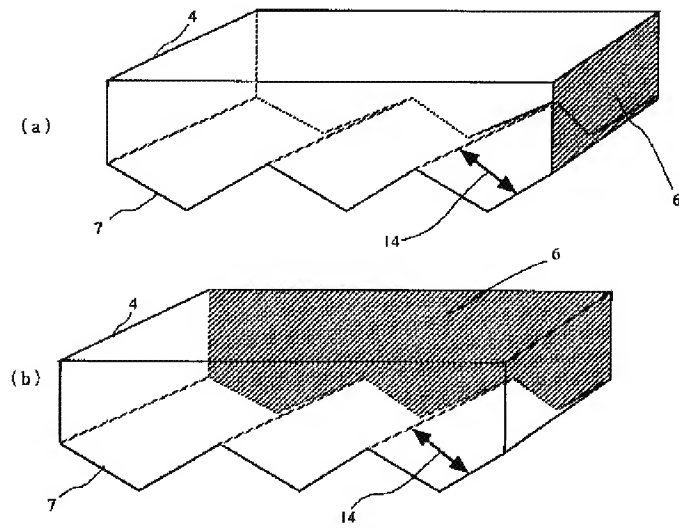
[FIG 9]



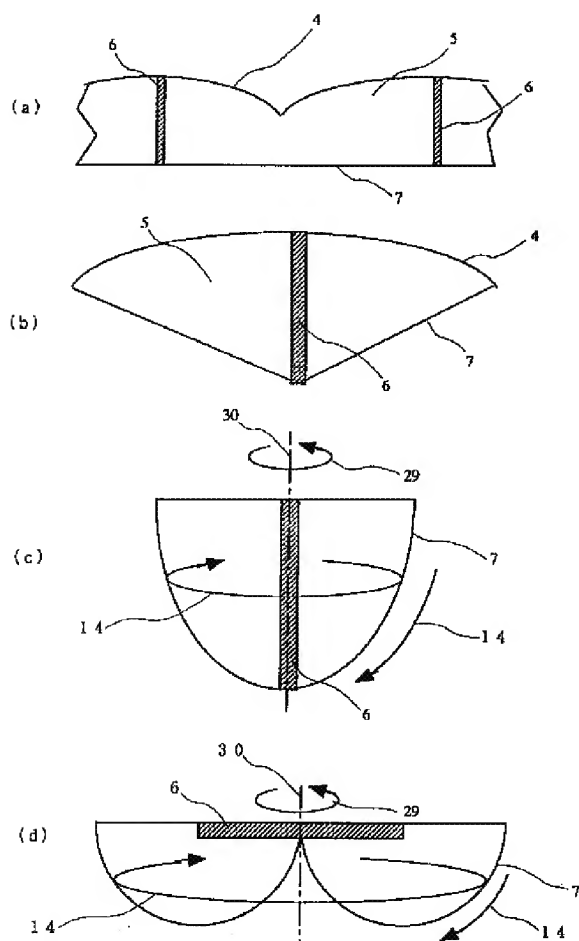
[FIG 10]



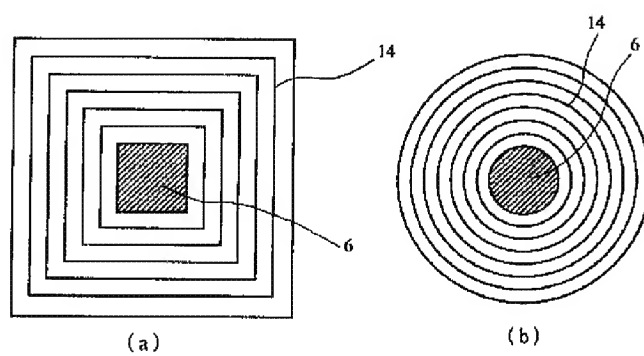
[FIG 11]



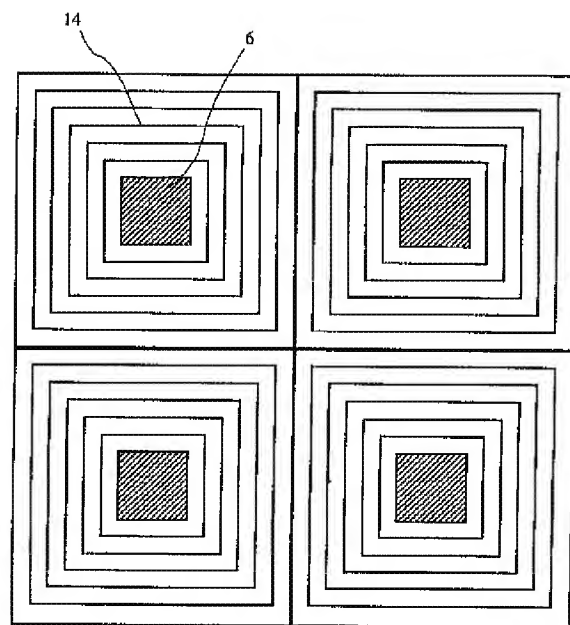
[FIG 12]



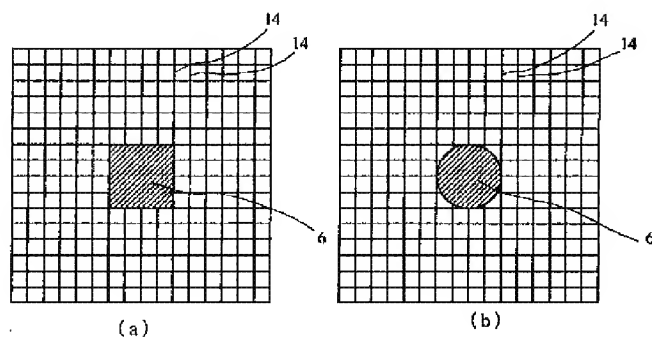
[FIG 13]



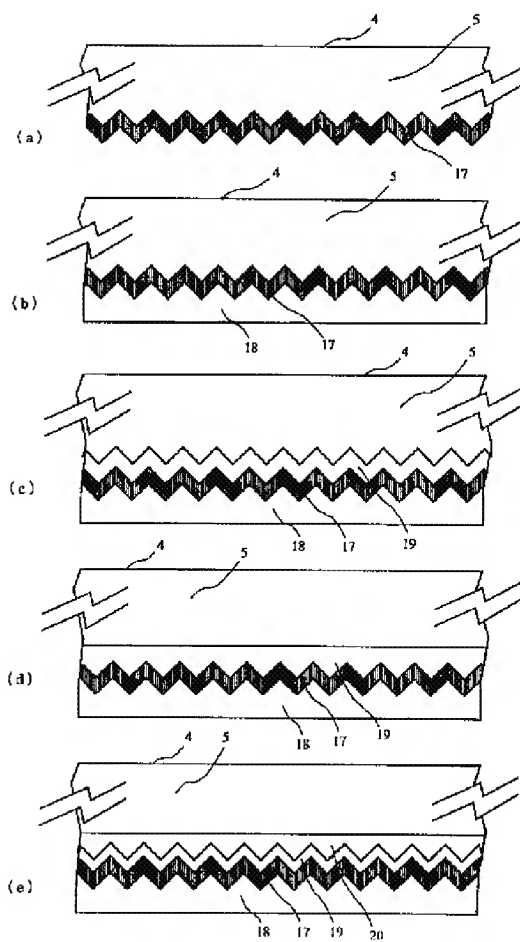
[FIG 14]



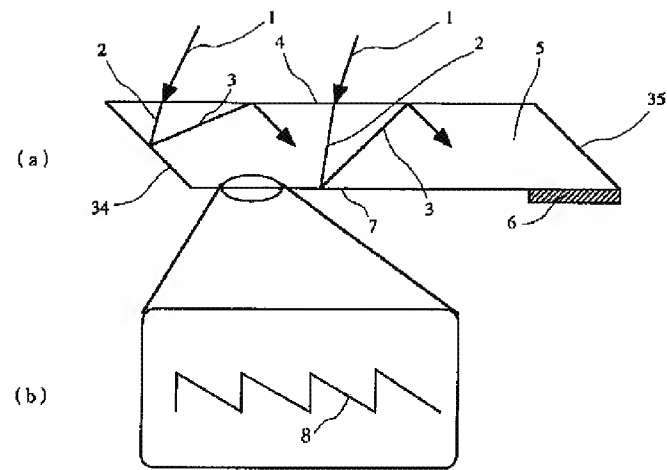
[FIG 15]



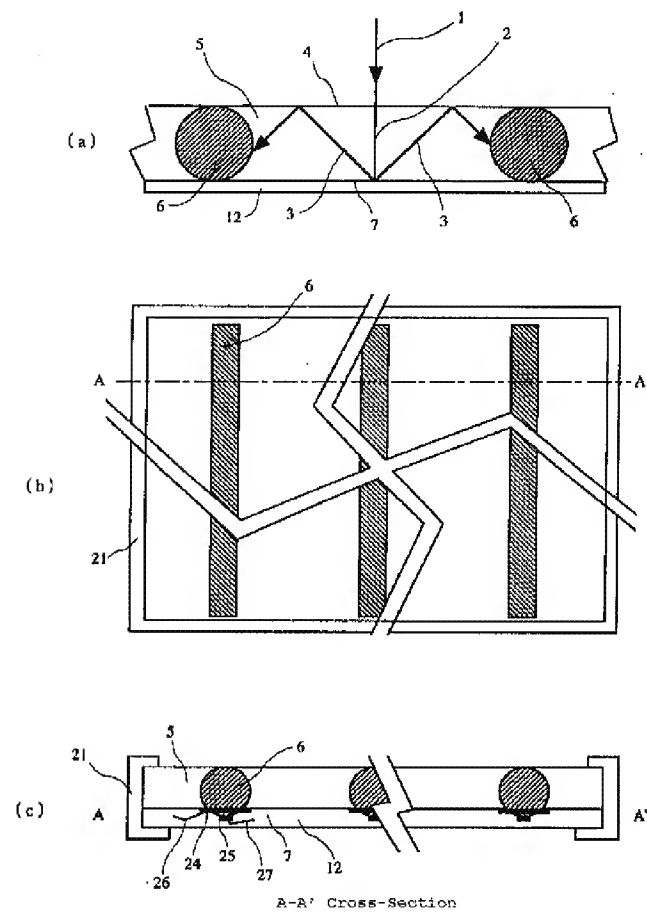
[FIG 16]



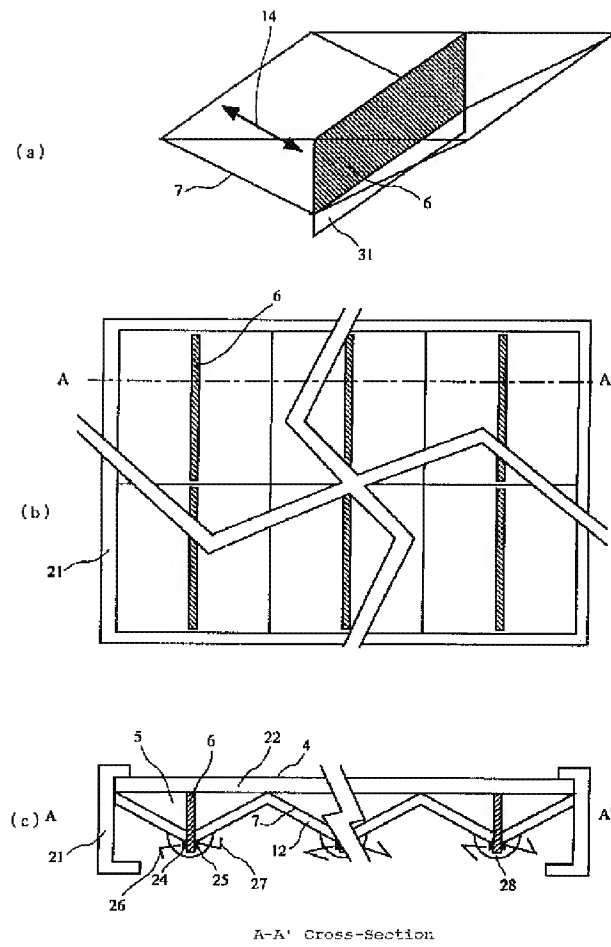
[FIG 17]



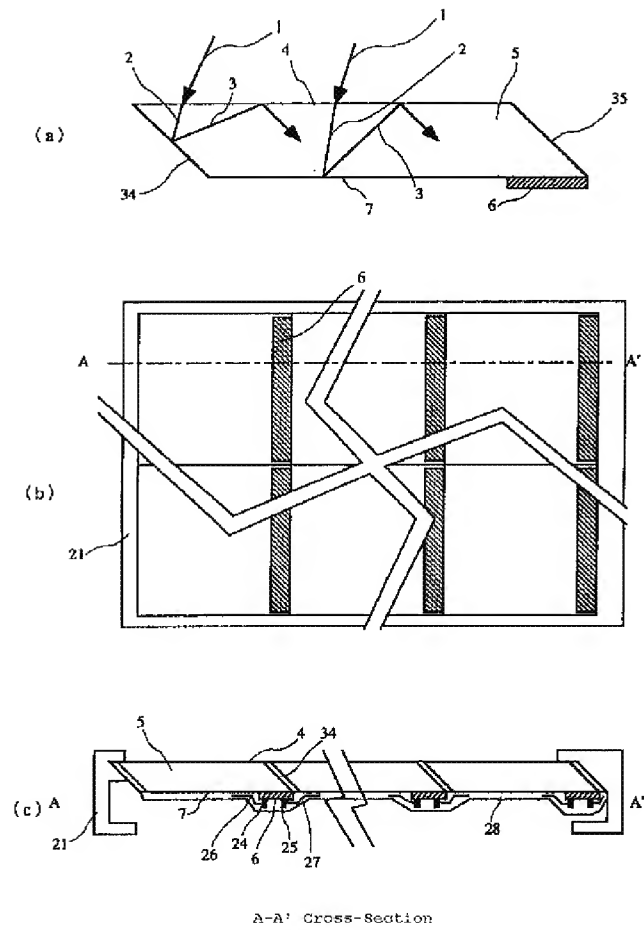
[FIG 18]



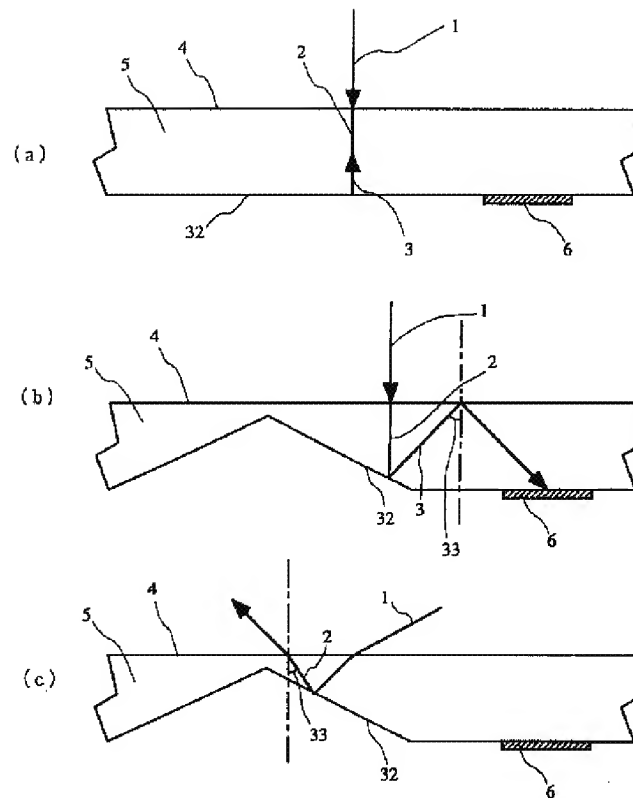
[FIG 19]



[FIG 20]



[FIG 21]



[Amendment of Proceedings]

[Filing Date] February 22, 1999

[Amendment 1]

[Amended Document] Specification

[Amended Item] Claim 4

[Amendment Method] Revision

[Content]

[Claim 4] The concentrator-type solar power generator described in claim 3, wherein the blazed diffraction plane has an asymmetrical blaze angle. [Japanese "spelling" error.]

[Amendment 2]

[Amended Document] Specification

[Amended Item] 0012

[Amendment Method] Revision

[Content]

[0012] (4) The blazed diffraction plane has an asymmetrical blaze angle. [Japanese "spelling" error.]